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Global envelope method – new trend in determining economic potential of rural areas

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Abstract. This paper uses the narrative method to critically analyze theoretical approaches and concepts related to the development of rural areas and discusses the identified research gap that allows for the search for new concepts and methodologies for determining the economic potential of rural areas. In the study, various statistical methods, including the new global envelope method and permutation tests, were used to calculate the economic potential of the global model and individual sub-models of the rural areas´ potential. The achieved results suggest that the sub-model calculation is more complex and time consuming than the calculation of the global model. The comparison has also shown that the degree of relevance of the individual sub-models is lower due to the application of four sub-test statistics compared to the one test used in the global model. The selected process thus complicates the identification of false-positive significant variables. Based on the results, it can be stated that the significant variables identified in each sub-model affect the economic potential of a given sub-model, and thus the overall economic potential of the municipality, when compared to the variables identified in the global model.

Keywords: regional development, model of development potential model, the Czech Republic, rural areas

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1. INTRODUCTION

In the last decade, the European Community, including a number of national governments of the EU member states, has become aware of the negative development of rural areas and the need to handle this problem (Pártlová et al., 2020b). As the authors state, it is indisputable that rural areas are highly distinct and diversified; their specificity determines the need for new or specialized theoretical knowledge, methodology for designing a rural area development strategy based on actual, up-to-date data regarding the

economic potential of the area or locality and resulting implementation of methodologies in user practice by this real knowledge (Pártlová et al., 2020). The issue of economic or business potential in the conditions of rural areas is not a commonly addressed topic in research or scholarly publications in the CR or abroad. There is a consensus regarding the importance of small and medium-sized enterprises for the national economies in their theoretical definition; however, in European states, there are different views on how to stop and address the negative development of SMEs (e.g., Hudáková & Masár, 2018; Cicea et al., 2019; Dowling et al., 2019). There is an increasing demand among managers of small and medium-sized enterprises (SMEs) for a novel methodology to analyse the internal and external environment, as they perceive the insufficient knowledge in this issue as a hindrance to the further development and survival of their firms (Prieto Sandoval at al., 2019).

Based on the analysis of various sources, (Fratesi & Perucca, 2019) state that there is a wide range of theoretical approaches to the development of rural areas. It is thus not possible to determine which of the theoretical approaches prevails or which of them would both fully respect the specifics of the Czech rural areas and satisfy their needs from the perspective of their current and future development. This statement should not be considered negative, rather, it highlights the difference that exists both in nomenclature and theoretical and practical aspects of various solutions, including elements such as the stability and sustainability of rural areas, as well as the possibility of their further development (Mensah, 2019). All this fosters the feelings of humility and respect with regard to the older development theories and methodologies while calling for the search of ways to enrich, develop, and innovate the existing approaches.

Rural areas experienced fundamental transformations at the end of the last century (Shi et al., 2019). Besides the clearly positive changes, there were also some negative phenomena, such as depopulation of rural municipalities or the reduction of the share of the original population. While in 2015, 28 % of the EU citizens lived in rural areas this share decreased to 21 % in 2020. This 7% difference is reflected in the increased number of EU citizens living in urban areas (Dax et al., 2021). Another negative trend going on in the rural areas is the change in the style of rural life often approaching to urban agglomerations, the decline of traditional rural crafts, historical socio-cultural activities, etc. (Wichowska, 2021). It follows from the above that addressing the issues related to rural areas represents a current need of the national economy.

The goal of the paper is to propose a new theoretical background for determining the economic potential of rural areas and based on this, to propose a method applicable in user practice that would allow the objectivization of the direction, scope, and intensity of business activities with the maximization of added value while minimizing costs in accordance with the natural potential area.

In line with the set goal, the following hypotheses were formulated:

H1: The determination of the economic potential on the basis of the four sub-models is more precise than the determination of the economic potential on the basis of one global model.

H2: The global economic potential shows more significant variables in comparison with the results determined for the global model.

2. LITERATURE REVIEW

The identification or calculation of the potential of rural areas including the specification of trends significantly affecting this potential is addressed in research conducted across various scientific disciplines. However, research of this type is mostly focused on the analysis of specific factors of rural areas. By their focus, they can be classified into several groups (Féret et al., 2020; Mantino, 2021; Górecka et al., 2022). The administrative approach (Borawska, 2017) was one of the first concepts focused on the regional administration with strictly demarcated regions, which means that the relationships between the rural and urban regions were not considered. Important supporters of this approach include Bański and Mazur, 2016;

Depraz, 2007; Dymitrow, 2013. The demographic approach (Chevalier et al., 2010; Depraz, 2007) is used mainly for characterizing the conditions for the purposes of the EU or in combination with another approach. The main obstacle to this approach is a requirement for a large database. On the contrary, the local approach differs from the administrative approach, and it aims to identify the conditions resulting from the relationship between the urban and rural regions (Dijkstra and Poelman, 2008, Bański and Mazur, 2016, Kouřilová et al., 2012). Bibby (2004) characterizes territory according to the type of economic activity (specialized or diversified agricultural activities) and especially according to the intensification of these activities within the same regional units. It is based on criteria such as the share of the primary sector on GDP, average income per capita, and the cost of services (education and health care). This approach differs from the spatial approach characteristic for Blanc (1997). Blanc specified territory and its potential on the basis of the spatial functional distribution of enterprises, availability of resources, distance, and transport costs. The author also defines the relationships of individual actors in the territory, where each actor is assigned a certain role. Landscape approach deals with territory from the perspective of environmental elements, the degree of diversity, and the perspective of landscape fragmentation and its stability (Bański and Mazur, 2016). Landscape and socio-ecological approaches use data on land cover and climatic conditions in order to define landscape structures (van Eupen, 2012; Jasinavičiūtė & Veteikis, 2022). Other criteria used include building density, degree of urbanization, continuity of built-up area, and forest percentage. Within this approach, a derived approach emerged, which includes also the economic, infrastructural, socio-economic aspects, namely the anthropo-ecological concept of rural areas, which have become a theoretical basis for determining the development or economic potential of a territory (Jasinavičiūtė & Veteikis, 2022). It is a combined approach that includes a number of parameters from the above approaches, most usually combining the criteria used in localization and structural approaches (e.g., Rosner, 2008; Prieto-Lara & Ocaña-Riola, 2010; Copus, 2013) or localization and landscape approaches (Dijkstra and Ruiz, 2010; Berchoux et al., 2019).

Authors Greene et al. (1997), Lu and Jacobs (2013), Cejda (2012), Gyawali et al. (2013), Gorzelak (2019), Heffner & Twardzik (2022), Egidi et al. (2021) focus on socio-economic conditions in a region and identify factors (globalization of workforce, structure of agriculture, stagnating economic development, changes in rural culture, environmental changes, decrease in available and qualified workforce) which significantly influence the potential of territory. Research by Lichter 2012, Cohn & Hasting (2013), and Rosengren et al. (2019) aimed to specify the relationships of the factors examined. The authors concluded that lower economic potential of a territory is significantly affected by less qualified people with lower income. White (2012), Measham et al. (2012), Ibanescu et al. (2018) & Fotiadis et al. (2019) deal with demonstrating the existence of a significant dependence of demographic factors and economic cycles, the extent of rural tourism, and analysis of tertiary sector. In their research, they point to the importance and identification of exogenous factor, especially those related to environmental protection and agro-environmental measures adopted in agriculture. Such factors include natural habitat, which contributes to the character of a given locality and creates or specifies conditions for business activities (Townsend et al., 2020; Frazier et al., 2013). Greene et al., (1997) and Mazur & Tomashuk (2020) focus on key factors influencing social conditions in rural areas. They emphasize the diversification of the rural population, education, income, a higher percentage of aging population, or the outflow of younger qualified people from rural areas to towns (Cejda, 2012; Gyawali et al., 2013; Deller et al., 2019). The outflow of economically active population does not occur in all rural areas. In some localities (when small municipalities have close ties to towns), the dynamics of the rural community is much more diverse, since people are willing to move from towns to rural areas (Martin and Sunley, 2003; Strakova, 2020). People from rural areas may not appreciate the same values and beliefs as rural communities. Conversely, rural natives tend to have conflicting, often negative attitudes towards progressive business activities, innovations, and changes

(Martin and Sunley, 2003; Strakova, 2020). The findings show how important it is to understand the uniqueness and dynamics of rural areas in identifying the business potential to activate a good social climate, as well as establishing effective cooperation between the actors in rural areas (Mazur & Tomashuk, 2020).

The remoteness of rural areas often turns into economic and social disadvantage and causes degradation processes over time (Townsend et al., 2020). The research by Maidment (2020) thus focuses on the quality of the infrastructure network in relation to the development of business activities in rural areas. The author further states that an important factor that influences the potential of rural areas is the construction of a sufficient infrastructure network and ensuring a quality connection of urban agglomerations with rural regions. Li et al. (2019) and Pártlová (2020b) add that it is necessary to strengthen the functional links or establish functional information flows by means of creating networks between towns and rural areas on the basis of activating the human potential that actually exists there. The assumption is that a newly conceived economic, business, and social potential can be built based on the multidimensional networking of both types of agglomerations. The multidimensionality of such development potential should become an instrument for the stability and development of urban and rural agglomerations in harmony with each other, with a synergic effect, and with long-term sustainability.

3. METHODOLOGY

In the article submitted, narrative method is used, on which the review of the used literature is based. This leads to the identification of gathered empirical findings, and the theoretical approaches and concepts were synthesized and critically assessed. In this context, narrative method can be considered a relevant method to achieve the objective of the article, since a literature review is necessary for the identification of a specific place or research gap, which will create space for finding a new concept, framework, or theory; it also helps to specify research questions or hypotheses that need to be examined within the research activities (Paré et al., 2015). The literature review prepared within this article shows that the economic potential of rural areas has not been determined using all four pillars with a focus on characterising the economic, social, infrastructural and environmental conditions of a given territory. It indicates that the methods which have been used so far for the identification or analysis of the development potential may generate a certain degree of error rate. It is based on the statistical analysis of data and its multiple testing.

In order to identify and evaluate the potential of a given territory in the CR, a database containing 29 indicators was created. The indicators are divided into four pillars of rural areas (PVP). The territory under review consisted of 603 municipalities. The economic pillar contains four indicators, while the social pillar, 7 indicators. The infrastructural pillar includes 11 indicators, while 7 indicators are included in the environmental pillar. The indicators were assigned codes from K101 to K407 (see Table 1 below).

The process of determining the economic potential considering research levels, research objective, and partly the practice of statistics includes several steps:

As part of the exploratory level, data exploitation will be carried out, which is aimed at testing the models with regard to the detection of the so-called insufficient adaptation of the models. The null statistical hypothesis is tested at the selected significance level. The suitability of the models will be verified using the standard exploratory analysis, such as the graph of the standard residuals and QQ plot.

Table 1

Specification of indicators in individual pillars

CODE	**Economic pillar**	K304	Accessibility of railway stations
K101	index of economic structure progressivity	K305	Residents living in permanently occupied dwellings with gas supply, water supply, and public sewerage
K102	Trend of index of economic structure	K306	Availability of kindergartens
K103	Economic activity rate	K307	Availability of primary schools
K104	Recreation potential in recreational zone	K308	Availability of secondary schools with maturita exam
KOD	**Social pillar**	K309	Availability of nursing homes
K201	Population density	K310	Availability of GP surgeries for adults
K202	Population aging (increase in the number of seniors) – Aging index trend	K311	Accessibility of hospitals and outpatient facilities
K203	Trend of economic dependency index	**CODE**	**Environmental pillar**
K204	Natives - Economic dependency index	K401	Productivity of soil fund
K205	Trend of increase in the number of inhabitants with university education	K402	Landscape fragmentation
K206	Trend of unemployment rate	K403	Share of waters
K207	Czech citizenship	K404	Chemical status of surface waters
CODE	**Institutional and infrastructural pillar**	K405	Soil ploughing trend
K301	Transport serviceability in an area by public transport on working days	K406	Endangered forest zones
K302	– Transport serviceability in an area by public transport on Saturdays	K407	Trend of specific territorial emissions from stationary sources
K303	Accessibility of an area by first-class roads and roads of higher classes		

Source: Authors' results.

Subsequently, the sub-models and global models will be calculated and created using the statistical methods.

3.1. Sub-models

For the calculation of the economic potential of individual sub-models, linear regression models were used:

$$Y = X\beta + \varepsilon \quad (1)$$

Where the main problem seems to be a large number of regressors in the X matrix.

However, there can be a situation where there are many other parameters:

$$\beta i, i = 1, \ldots, p \; cannot \; be \; rejected \; H0: \beta i = 0 \quad (2)$$

For these reasons, some regressors are omitted (i-th columns of the X matrix). Therefore, it is possible to create more simple linear models. One way to find optimal subsets of independent variables for the linear regression model are the stepwise selection methods. The economic potential of individual models of stepwise regression models is calculated using the stepwise backward analysis. This method was used to determine the dependencies of other factors on the factors of the economic pillar aimed at the projection of the optimal model of the economic pillar for a given territory. The stepwise regression method is a method of finding the "best" model (with the lowest possible number of independent variables and the most possible quality prediction). The subject of the analysis is not to determine the order of variables

(predictors) in terms of their entry into the model, as this is part of the algorithm of the program. The backward variant was used where all predictors are first included and then gradually removed, and their significance within the tested indicator is analysed.

For the creation of the global model, the rank envelope test was used, which provides a global envelope as well as the p-value of the test. Rank envelope test is fully non-parametric and thus not sensitive to the changes in the distribution in the test statistic $T(r)$ for various $r \in I$ (where I is a set of values r entering the test). All tested values r have the same weight. This enables the construction of the test on the basis of several test functions at the same time. The calculation is as follows:

The tested function $T1: I \rightarrow R$, which is calculated on the basis of the data, and the set of simulations $T2, \ldots, Ts + 1: I \rightarrow R$ obtained with the assumption of null hypothesis. Afterwards, the k-th and lower rank envelope is defined:

$$T\ (k)\ low(r) = mink\ i = 1, \ldots, s + 1Ti(r) \tag{3}$$

$$T(k)\ upp(r) = maxk\ i = 1, \ldots, s + 1Ti(r) \tag{4}$$

$$k\ = 1, \ldots, \lfloor s/2 \rfloor \tag{5}$$

Where mink and maxk indicate the k-th lowest and highest values.

The extreme order Ri is as follows:

$$T(k)low(r) \leq Ti(r) \leq T(k)upp(r) \text{ for all } r \in I. \tag{6}$$

The high value of Ri indicates that the function Ti is a central function in the set $\{T1, \ldots, Ts + 1\}$, while the low value of Ri indicates extremity.

Next, the lowest p-value is defined, which is marked as liberal,

$$p- =\ 1\ s + 1\ s + 1 \tag{7}$$

$$\sum i = 1\ 1(Ri\ <\ R1) \tag{8}$$

while the highest p-value is marked as conservative

$$p+ =\ 1\ s + 1\ s + 1 \tag{9}$$

$$\sum i = 1\ 1(Ri\ \leq\ R1). \tag{10}$$

The output of the test is the p-interval $(p-, p+]$.

For the level of significance $\alpha\ \geq\ p +$ the null hypothesis is rejected,

For the level of significance $\alpha\ <\ p -$ the null hypothesis is not rejected $100 \cdot (1 - \alpha)\%$ the global envelope is constructed as follows:

There is also a number of simulations, then i $\in \{1, \ldots, s\ +\ 1\}$, for which $T(k)low(r) \leq Ti(r) \leq T(k)\ upp(r)$ for all $r \in I$.

Then $100 \cdot (1 - \alpha)\%$ is the global envelope given by the critical limits of T(envelope) upp and T(envelope) low, where kα is the highest k, for which $tk/(s + 1) \geq 1 - \alpha$. The interpretation of the test, which corresponds to the interpretation of the p-interval, is as follows (see Figure 2):

- If the tested function T1 or its part is outside $100 \cdot (1 - \alpha)\%$ global envelope, then $p+ \leq\ \alpha$ and the null hypothesis is rejected at the determined test level α.
- If the function T1 is inside $100 \cdot (1 -\ \alpha)\%$ global envelope and does not reach its limit, then $p- >\ \alpha$ and the null hypothesis is not rejected.
- If the function T1 is inside the envelope and reaches its limit, then $p- \leq\ \alpha\ <\ p +\ a$ and the decision is in the "grey zone".

4. EMPIRICAL RESULTS

Economic development potential, and especially its most important component, business potential, can be described as limiting for rural areas, their sustainability and development. It is mainly small and medium-sized enterprises that operate in rural areas. SMEs are the backbone of every national economy within the European economic area. Within this article, a new approach is proposed for determining the economic potential of rural areas on the example of the South Bohemian region (the Czech Republic).

For the purposes of analysing the economic potential of rural areas, four sub-models were proposed, which create a background for the analysis of the regional economic development potential (Pártlová, 2021):

- Sub-model 1: INXPES (index of economic structure progressivity).
- Sub-model 2: TIPES (Trend of index of economic structure progressivity).
- Sub-model 3: MPA (Economic activity rate).
- Sub-model 4: INXRCR (recreation and tourism index)

Each individual model examined within the analysis above shows the significance or insignificance for each variable analysed (variables for the other three pillars). Subsequently, the significance of each explanatory variable for a municipality as a whole is tested four times, once for each index, separately. This approach requires multiple testing. The problem of multiple testing of hypotheses (multiple testing problem) consists in the fact that the probability of obtaining a false positive result grows with the growing number of hypotheses tested, i.e., there is an increased probability that in testing, insignificant variables will be identified as statistically significant. To solve this problem, the so-called correction for multiple testing is used. The best-known correction procedure for multiple testing of hypotheses is Bonferroni correction, which rejects the null hypothesis if the calculated value is lower or equal to the level of significance (usually 0.05) and the number of tests performed. The application of Bonferroni correction is quite conservative, which means that it is relatively difficult to achieve statistical significance (especially if the number of tests performed is greater than 10). For this reason, a different method for multiple testing correction through permutation tests and global envelopes was selected (Mrkvička et al., 2017). The global envelope method uses permutations from a null model for calculating the regression parameters (test statistics) of the null model. They are then used for obtaining an envelope, which represents the value of test statistics, for which the null hypothesis is not rejected. The method of global envelopes was used to create significance tests with all explanatory variables included. The calculation is carried out for a municipality as a unit, when the significance of the remaining 25 indicators from other three pillars is tested using stepwise backward regression and the significance for the economic potential of the municipality is identified (the economic potential of municipality is represented by the first pillar, i.e., four variables in our case). In each step, insignificant indicators, i.e., the indicators which do not show significant dependence on the overall global model of the municipality, are removed.

Following the new calculation, or the determination of the economic potential of rural regions, a structure of models was proposed, which corresponds to four variables in the economic pillar. The methodological basis for such a solution is represented by the four pillars with relevant sets of indicators. The proposed pillars and relevant indicators follow the basic structure of anthropo-ecological system of rural areas. Subsequently, the methodological processes were set for calculating partial potentials (models) DM (see Table 2) and the overall global economic potential of the given territory (see Table 3).

Creation of sub-models: sub-model 1: INXPES (index of economic structure progressivity), sub-model 2: TIPES (trend of index of economic structure), sub-model 3: MPA (Economic activity rate), and sub-model 4: INXRCR (recreation and tourism index) proved the suitability of their setting in the conditions of selected regions in the CR.

The resulting table implies that the most significant variables identified are in the INXRCR model. The positive effect on the potential of recreation and tourism in the territory under review was observed in the case of K206, K301, K303, K307, K309, and K403; negative effect was observed in the case of K204, K311, K401, K405, and K406.

Another model with a high number of significant variables is INXPES. The economic structure of the given territory is positively influenced by K205, K301, K306, and K402; a negative effect was observed in the case of factors K204 and K308.

MPA (economic activity rate) is a model that captures the economic performance of regions. In this model, significance was confirmed for 4 variables. In terms of a positive or negative effect of the tested variables on the model, positive effects can be expected in the case of K205; K204, K310, K406 show a negative effect.

For the TIPES model, two indicators were identified to influence the given model. A relatively high positive value of dependence was calculated for the indicator K202. The economic structure of individual sectors and its trend is related to the population density in a given area. Landscape fragmentation (K402) achieves similar values as in the case of INXPES, that is, negative significance.

The submitted paper uses narrative method, on which the literary research is based. The literature review enables the identification of gathered empirical findings and the synthesis of theoretical approaches and concepts, which were then critically assessed. In this context, narrative method can be considered a relevant method to achieve the objective of the article, since literature review is necessary for the identification of a specific place or research gap, which will create space for finding a new concept, framework, or theory; it also helps to specify research questions or hypotheses that need to be examined within the research activities (Paré et al., 2015). As already mentioned above, the literature review prepared within this article shows that the economic potential of rural areas has not been determined using all four pillars with a focus on characterising the economic, social, infrastructural, and environmental conditions of a given territory and indicates that the methods used so far for the identification or analysis of the development potential may generate a certain degree of error rate. It is based on the statistical analysis of data and its multiple testing.

In order to identify and evaluate the potential of a given territory in the CR, a database containing 29 indicators was created, which was divided into four pillars of rural areas (PVP). The territory under review consisted of 603 municipalities, with the economic pillar containing four indicators, the social pillar 7, 11 indicators in theI infrastructural pillar and 7 indicators in the environmental pillar. The indicators were assigned codes from K101 to K407 (see Table 2 below).

The next step was to create a complex global model, including the presentation of differences in comparison with individual proposed sub-models. In the results, important trends following from the results of the global model are outlined.

The output of the second method (the global model) is the identification of a large set of variables (10 significant indicators - K204, K205, K206, K301, K307, K309, K401, K402, K405, and K406), which turned out to be significant for the economic potential of the municipality from the global perspective (indices K101, K102, K103, K104). Thanks to the global test, it can be said that these variables influence the economic potential of the municipalities located on the territory of the region under review, with at least one of the indices achieving the global level of significance of 0.05.

Table 2

Individual SM and their significant variables

Model summary								
$model\ INXPES = lm(101 \sim K204 + K205 + K301 + K306 + K308 + K402, data = M)$ $model\ TIPES = lm(102 \sim K205 + K301 + K306 + K308 + K402, data = M)$ $model\ MPA = lm(103 \sim K204 + K205 + K310 + K406, data = M)$ $model\ INXRCR = lm(104 \sim K204 + K206 + K301 + K303 + K307 + K309 + K311 + K401 + K403 + K405 + K406, data = M)$								
Coefficients								
predictors	**estimate model INXPES**	**p-value**	**estimate model TIPES**	**p-value**	**estimate model MPA**	**p-value**	**estimate model INXRCR**	**p-value**
(Intercept)	2.6	0	0.186	0	194.153	0	129.89	0
K201	-	-	-	0.019	-	-	-	-
K202	-	-	0	-	-	-	-	-
K204	-0.006	0	-	-	-0.662	0.001	-0.188	0
K205	0.006	0.003	-	-	3.291	0.001	-	-
K206	-	-	-	-	-	-	0.513	0.003
K301	0.001	0	-	-	-	-	0.04	0
K303	-	-	-	-	-	-	0.24	0.006
K306	0.014	0.002	-	-		-	-	-
K307	-	-	-	-	-	-	0.522	0
K308	-0.003	0.007	-	-	-	-	-	-
K309	-	-	-	-	-	-	0.279	0.002
K310	-	-	-	-	-3.687	0.012	-	-
K311	-	-	-	-	-	-	-0.173	0.035
K401	-	-	-	-	-	-	-1.642	0.006
K402	0.188	0.046	-0.242	0.007	-	-	-	-
K403	-	-	-	-	-	-	0.184	0.013
K405	-	-	-	-	-	-	-0.484	0
K406	-	-	-	-	-7.06	0.014	-11.655	0

Source: Authors' results.

The construction of the global model using global envelopes can be presented on the basis of results in Table 3 and Graph 1 (see below). The table shows the determined significance for individual explanatory variables (in the column "predictors") and estimates of all regression parameters (the columns estimate K101 – K104) for a complete global model of municipality economic potential. The individual values indicate which predictors (variables) are significant for the global model of municipality economic potential and whether they show positive or negative values. In terms of comparison with the previous four models, an interesting result appears to be the fact that no significant variable was identified for the indicator K102 from the global point of view (trend of index of economic structure progressivity - estimate K102). In the previous sub-model of trend of economic structure index, the identified significant variables were K201 and K202. Even for the indicator K101 in the global model (index of economic structure progressivity - estimate K101) in comparison with the sub-model of the economic structure progressivity index, a match was found for variables K204, K205, K301, a significant variable K307 appeared, but no significant variables K308 and K402 compared to the sub-model. Similarly, the dependent variables were reduced in the case of the indicator K103 (economic activity rate – estimate K103). In the global model, no significant values were identified for K205 and K310. The last index of the economic pillar (recreation and tourism index – estimate K104) in the global model compared to the sub-model shows two reduced significant variables, K303 and K311, as these variables no longer proved to be significant in the global model.

Table 3

Global model of municipality economic potential

Model summary					
$model = lm(101,102,103,104 \sim K204 + K205 + K206 + K301 + K307 + K309 + K401 + K402 + K405 + K406, data = M)$					
Coefficients					
predictors	**estimate K101**	**estimate K102**	**estimate K103**	**estimate K104**	**p-value**
(Intercept)	2.5326562	0.2006255	210.95789	130.87233	0.635
K204	**-0.0058869**	-0.0002813	**-0.63608**	**-0.18609**	<0.001
K205	**0.0069634**	0.0006568	3.20565	0.21783	<0.001
K206	-0.0021079	-0.0042225	-1.29620	**0.49231**	0.013
K301	**0.0010062**	-0.0002688	-0.05526	**0.05316**	<0.001
K307	**0.0055309**	-0.0036380	-0.97777	**0.50569**	<0.001
K309	-0.0016188	-0.0003376	-0.47652	**0.25824**	0.017
K401	0.0019445	-0.0058559	-0.85448	**-1.79870**	0.014
K402	0.2083627	-0.2201259	3.96842	**-18.68154**	0.049
K405	-0.0014216	-0.0017256	-0.03847	**-0.47107**	0.001
K406	0.0077439	0.0030457	**-8.78668**	**-11.76310**	<0.001

Source: Authors' results.

Legend: K101 – index of economic structure progressivity; K102 – trend of index of economic structure progressivity; K103 – economic activity rate; K104 – recreation and tourism index; K204 –Natives – index of economic dependency; K205 –Trend of increase in the number of inhabitants with university education; K206 – trend of unemployment rate; K301 –Transport serviceability in an area by public transport on working days; K307 – Availability of primary schools; K309 – availability of nursing homes; K401 – Productivity of soil fund; K402 – ecological fragmentation; K405 –Soil ploughing trend; K406 – endangered forest zones.

The significant values which protrude of the envelope prove the significance of the model and are marked in bold.

Based on the following graph, it is possible to identify the estimated regression parameters (indicator K204) of a relevant model for all indices K101, K102, K103, K104 (r on the x-axis) using a cross. The so-called whiskers show the global envelope, i.e., the area ((βi) ˆ(r) on the y-axis), where the significance of individual parameters is not rejected. The red crosses mark the regression parameters protruding of the envelope and prove the significance of the whole model (the global model). At the same time, it is also possible to identify for which index significance is demonstrated. This is then confirmed by the global p-value displayed in the chart header.

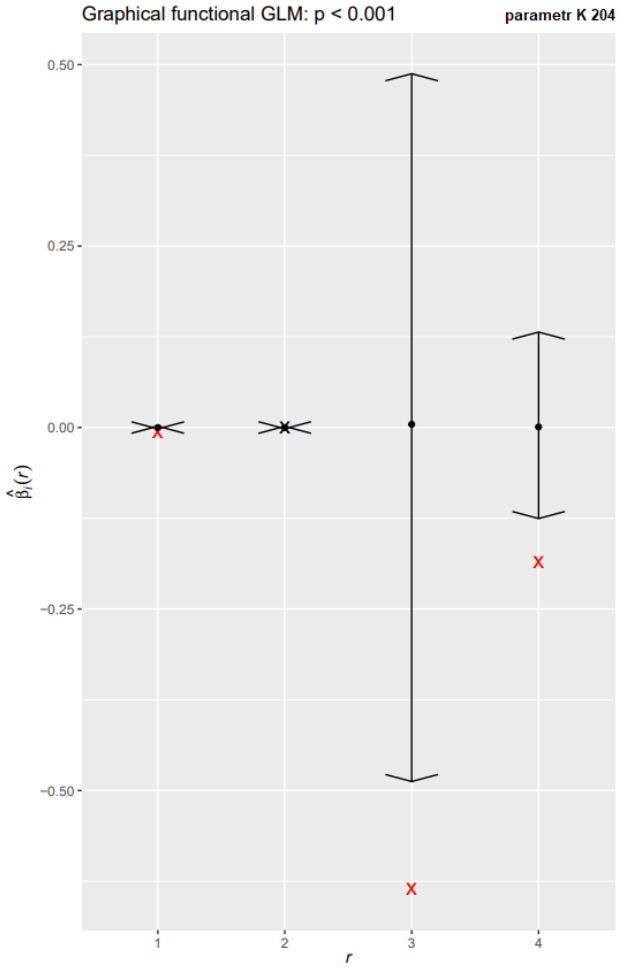

Figure 1. Example of graphical processing of the regression parameter K204 in a relevant model for the indices of the economic pillar (K101, K102, K103, K104)

Source: Authors' results.

The remaining variables (K205, K206, K301, K307, K309, K401, K402, K405, and K406), identified through regression analysis as significant parameters for evaluating the municipality potential from the global perspective are presented in the form of graphs, stored in the author´s archive.

A detailed analysis of the global model results enabled the identification of the following trends:

- The share of natives (people living in the place of their birth) on the total number of inhabitants grows with the municipality size. A lower share of natives is around large towns, where sub-urbanization processes have been acting since the 1990s.
- Territories with a higher unemployment rate show a higher natural potential. It can thus be assumed that the unemployment rate in these territories can be reduced by means of using the identified potential of tourism and available infrastructural network.
- Ensuring sufficient public infrastructure is often related to the development of residential or economic potential. This process is desired in the development of tourism to some extent, since development of tourism means opportunities for a given locality. However, it should be noted that a higher development of tourism results in increased entrepreneurial activities but also in pressure on local governments and public institutions to ensure tourism infrastructure. There are tendencies to replace the original function of settlements with tourism function (e.g., to replace residential

buildings with tourism facilities and related activities of visitors and entrepreneurs). The factor of transport serviceability of the territory by public transport on working days relates to the geographical location of a given territory. Transport serviceability still seems to be a key factor for the development of a given territory.

- The high development potential of tourism is significantly influenced by the aesthetic value of the cultural landscape, the occurrence of natural sites, etc. These attributes are related to other factors, specifically the productivity of soil fund, soil ploughing trend, percentage of water bodies, and endangered forest zones. All these factors influence the natural potential of tourism development and entrepreneurial activities in a given area. Activities such as agriculture, forestry, transport, and settlement use soil and change its natural condition and functions. The use of soil is related to several environmental issues, such as biodiversity loss and water pollution, soil degradation, or land take. The impacts can be both direct, such as habitat and landscape destruction, or indirect, such as land cover and deforestation. Both these negative aspects directly affect the attractiveness of tourism and thus its economic development potential. Interesting findings were obtained in the case of endangered forest zones and its impact on the global model. It is necessary to find an optimal limit between business activities and the percentage of forest zones, especially those requiring certain nature protection. The research results show that even in such localities, business activities should be allowed but with great respect for the natural wealth of the given locality. From this point of view, it is necessary to initiate support for traditional business and crafts, and it is very important to create conditions for the development of small businesses in rural areas, and thus help small businesses in their activities and improve their competitiveness not only in the Czech market.
- The higher number of kindergartens and primary schools are located especially in territories with businesses operating in progressive economic sectors. This trend could be explained by the willingness of qualified young people to move to the regions where this component of public infrastructure is available.
- Other factors influencing this model include people with university education. University graduates with knowledge in the development of advanced technologies represent an important development accelerator of a region´s innovative potential. In the case of brain drain, the characteristics of the regional labour market deteriorate in the long run and the unemployment rate grows. It should be noted that university-educated population is diverse and in terms of migration, it can be divided into two different groups. Younger university graduates usually move from their municipality to large towns in the expectation of more interesting and better-paid job opportunities, including the possibility of career growth (see the previous variable). On the contrary, older graduates are looking for an attractive environment, with a higher quality of life, and move to large towns rather as part of ongoing suburbanization processes.

5. DISCUSSION

The results obtained point to two different approaches to determining the economic potential of rural areas. The first approach considers the construction of four models using the backward stepwise regression method; however, other analytic tools, such as GIS, can be used as well (Laatikainen et al., 2017; Komossa et al., 2018; Pártlová, 2020). Nevertheless, it has already been stated (Pártlová, 2020a) that models have their limitations both from the perspective of their presentation and their construction. For these reasons, the second approach was selected, i.e., the construction of the global model.

There shall be also mentioned that the construction of the four sub-models does not express the potential of the area as a whole, but rather individual potentials, which only describe the specifics in a given analysed area (business activity, tourism, etc.). Therefore, Hypothesis 1 can be rejected, as it has been proven that sub-models affect the economic performance of a specific model, while in the global model, the identified significant variable affects the economic potential of a given municipality within the analysed South Bohemian region as a whole. In other words, p-value is assigned to each analysed variable in the analysed sub-models, while in the global model, a single p-value is determined, the so-called adjusted p-value.

The calculation of sub-models appears to be more complicated compared to the use of the global model. In comparison with the use of the global model, the degree of relevance of the outputs is lower for the individual sub-models, because much more significant factors were identified in the case of the sub-models, not identified in the global method in the single test. Another limitation is the verification of the sub-models outside the South Bohemian region, since the analysed region has a natural character and is clearly different from e.g., completely industrial regions. Overall, it can be stated that by using the construction of one global model by means of the permutation test and global envelopes, it is possible to avoid multiple testing, which significantly reduces the possibility to identify statistically different variables, especially if more than 10 tests are used. The result is the reduction in the possibility of finding false significantly variables that explain the sub-models, which is also reflected in the results for the whole South Bohemian region, where the sub-models show more significant variables compared to the global model. It can thus be stated that Hypothesis 2 cannot be confirmed.

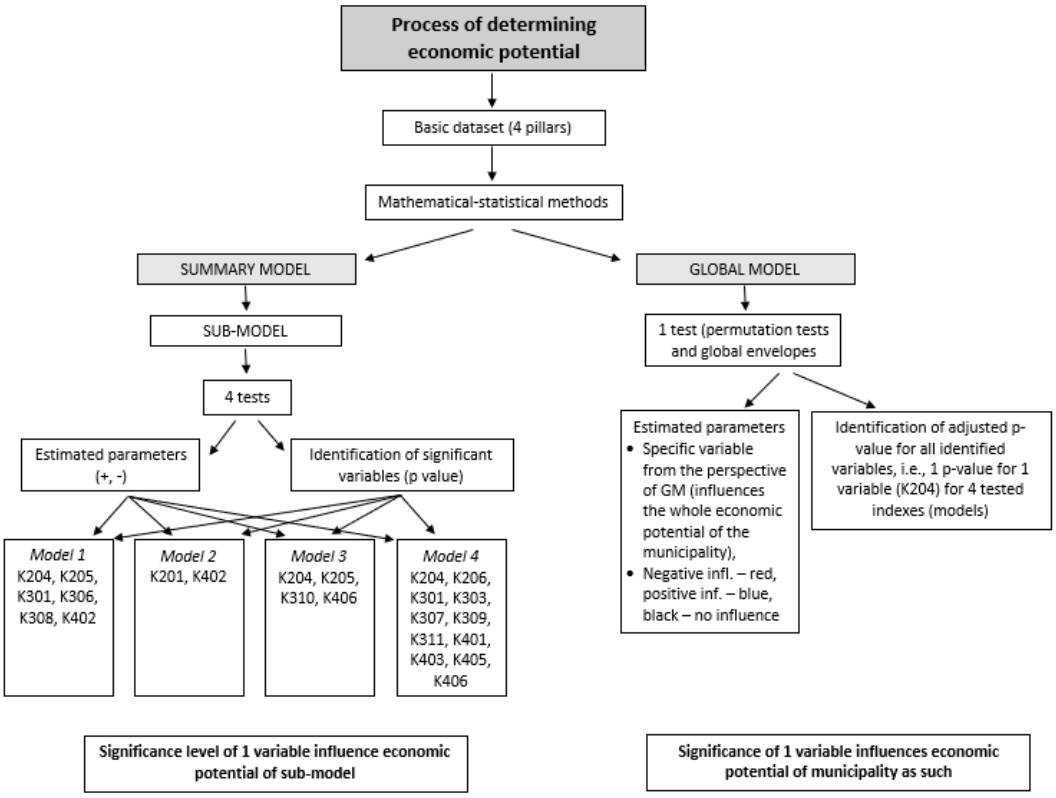

Figure 2. Used methodological principles:
Source: Authors' results.

Figure 3 shows the overall process of determining the economic potential of individual sub-models and the global model. It can also be seen from the figure that the p-value in the sub-model is related only to one explained variable, while in the global model, the global p-value is calculated for all explained variables together and the so-called adjusted p-value is assigned to them. This is due to the fact that only one test is used and the estimated parameters, or specific variable from the perspective of the global model, influences (variables s – a + in bold, see Table 3) the economic sub-index at the significance level of 5 % on the basis of the global model. Other variables in Table 3 do not have any effect on the global model.

6. CONCLUSION

The article submitted brings a new perspective on the analysis of rural areas in terms of identifying their economic development potential. Extensive literary research was carried out using both Czech and foreign resources. The performed analysis of the resources confirms the existence of (often fundamental) differences in the existing theoretical and practical solutions. It also presents an overview of opinions in the given field of determining the potential of rural areas. The detailed literary review shows that similar research has not been conducted yet in the Czech Republic or abroad. On the other hand, it limits the possibility of comparing the results with the outputs of other research institutions; however, the solution provides new scientific knowledge, which could be used for finding or identifying a particular space or research gap and thus create space for finding a new concept, as well as the introduction of two new methods to calculate the development potential of territory. To verify the new approach and two newly proposed methods for calculating the development potential, as well as a means of feedback in terms of relevance and validity of the outputs of the solution, a territory containing a total of 603 municipalities was selected.

On the example of this territory, a new global methodology for determining the economic potential of rural areas was presented, which resulted in identifying practical trends in interpreting the analysed values. The newly proposed method of determining economic potential is set in a form enabling its implementation at the level of a region, area, cadastral area of a municipality, areas of interest, or a segment of rural areas. It should be emphasized that the method of permutation tests and global envelopes has not been used yet for determining regional development, and the achieved results are more accurate, less erroneous, and more complex (see the comparison of the results presented in Tables 2 and 3).

To assess the scientific, business, administrative, and social community, new methodological procedures to calculate the economic potential of a territory are introduced. First, four sub-models are presented, namely sub-model 1 – index of economic structure progressivity, sub-model 2 – trend of economic structure index, sub-model 3 – economic activity rate, and sub-model 4 – index of recreation and tourism. Subsequently, the models are compared with a single global model. The results of the verification in user practice confirm the suitability of the outputs, of course with the requirement for further specification, supplementing, and mainly the completion by means of user software with an accompanying manual.

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